Antibiotics use affects the abundance of resistant bacteria in soil

March 7 2016, by Janne Hansen

There is a relation between the use of antibiotics and the appearance of genes for antibiotic resistance in the environment. Credit: Janne Hansen

The use of animal manure increases the soil content of antibiotic-resistant genes. However, this is not an irreversible situation.

What does one of the world's longest-running field experiments - under Aarhus University in Denmark - have to do with the appearance of antibiotic resistance? The answer is that it forms the platform for illuminating the interaction between the use of animal manure and the appearance of genes for antibiotic resistance in soil.

New investigations show that when a certain type of antibiotic is phased in, the abundance of resistant genes in soil increases. When the antibiotic is phased out again, the abundance of resistant genes drops - and this happens relatively quickly. The scientists also found a correspondence in time between the first detection of antibiotic resistance in the health service and the detection of such genes for resistance in soil that had received applications of animal manure.

The analyses have been performed by British scientists using soil samples regularly collected since 1923 in the now 122-year-old fertiliser experiment at Askov Experimental Station at the Department of Agroecology, Aarhus University. The results of this partnership among Prof Bent Tolstrup Christensen (Aarhus University), Prof David W. Graham (project leader, Newcastle University in England) and Dr Charles Knapp (Strathclyde University in Scotland) have been described in an article in the prestigious scientific journal Nature *Scientific Reports*.

Resistance follows the rate of consumption

That bacteria can develop resistance to bacteria is not a new phenomenon. Genes that code for resistance to antibiotics existed even before we discovered and started using antibiotics. Multi-resistant genes have actually been found in 30,000-year-old DNA samples taken in permafrost areas. The problem is that a higher incidence of resistance to antibiotics is highly undesirable.

The experts studied the specific β-lactam antibiotic resistant genes. Particularly this group of antibiotics is of considerable importance to human medicine. The resistant genes were chosen because their first appearance in the health system is well-documented.

"We found low levels of the resistant genes before 1960, both in manured soil and in soil treated with inorganic fertiliser," explains Prof Christensen from Department of Agroecology. He is project leader of the Askov Long-term Experiments and co-author of the article.

"Our analyses show a clear increase in the soil receiving animal manure. In the mid-1990s, the use of antibiotics as a growth promoter fell. This led to a corresponding rapid fall in the soil abundance of β-lactam antibiotic resistant genes," says Christensen.

Throughout the period, the soil receiving inorganic fertiliser had very low levels of the resistant genes.

There is good news and there is bad news

Another important link is that the development of the abundance in soil of β-lactam antibiotic resistant genes closely trail observations of their development in the health service. The timing of the first appearances of the resistant genes in the health service corresponds to the timing of their highest abundance in soil.

"Although the development in the abundance of resistant genes in soil mirrors what you see in the health service, research has not yet made a connection between the two. The results show, however, that the phasing out of antibiotics can swiftly lead to a reduction in the incidence of resistance - and that is good news," says Christensen.

The story does not end here. Analyses of the historical samples also showed another development that is more worrying. Since 1990 there has been a growing level of integrons in manured soil. Integrons promote the exchange of genetic material between bacteria and can therefore accelerate the development of new resistance.

"The rising level of integrons after 1990 in manured soil could indicate that through our efforts to reduce antibiotic resistance, we have unintentionally increased resistance gene exchange and more study is needed on the use of animal manure," says Prof Graham from Newcastle University.

More information: David W. Graham et al. Appearance of β-lactam Resistance Genes in Agricultural Soils and Clinical Isolates over the 20th Century, *Scientific Reports* (2016). DOI: 10.1038/srep21550

Provided by Aarhus University